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(E72-10255) INVESTIGATION OF TECHNIQUES FOR CORRECTING ERTS DATA FOR SOLAR AND ATMOSPHERIC EFFECTS Bimonthly Progress Report, 1 Aug. - 1 Oct. 1972 R.H. Rogers (Bendix Corp.) 1 Oct. 1972 7 p CSCL 04A G3/13

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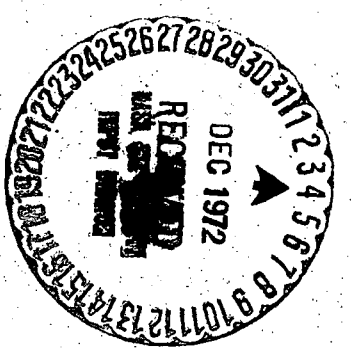
Bi-Monthly Progress Report

Reporting Period

1 August to 1 October 1972



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Prepared For: NASA/Goddard Space Flight Center

A. INVESTIGATION OF TECHNIQUES FOR CORRECTING ERTS DATA FOR SOLAR AND ATMOSPHERIC EFFECTS, MMC 655, PR 303, by Dr. R. H. Rogers

B. OBJECTIVE

The objective of this experiment is to establish a radiometric calibration technique that will permit the absolute reflectance characteristics of ground targets to be determined from ERTS spacecraft data.

1. Intermediate Goals

The accomplishment of this objective will entail the pursuit and accomplishment of intermediate goals that include:

- Development and evaluation of techniques to determine absolute reflectance of large natural and man-made targets from ground-based spot sampling with hand-held radiance measuring instruments and from the MSS data gathered by aircraft from low altitude.

- Development and evaluation of techniques to determine absolute target reflectance from ERTS data by the measurement and removal of the solar and atmospheric parameters derived from ground-based radiant power measurements. Additional subgoals achieved in the pursuit of this task include: development of a radiant power measuring instrument capable of measuring needed solar and atmospheric parameters, optimum techniques for use of this instrument, accuracy achievable and condition under which stated accuracy may be achieved.

- Establishment and evaluation of the capability of procedures for deriving atmospheric parameters needed to correct ERTS signal directly from spacecraft measurements (such as path radiance based on minimum radiance signal).

- Determination of the capability of data processing techniques to extend in time (repetitive coverage) and space the absolute calibration of the spacecraft data.

- Development and evaluation of computer software, techniques, and procedures for transforming the ERTS computer-compatible tapes (CCT) into a new set of tapes and images which have been corrected for solar and atmospheric effects.

- Inter-comparison of the capabilities of correcting the ERTS data for solar and atmospheric parameters and effects by candidate radiometric calibration techniques that include: (1) transference calibration, (2) ground-based radiant power measurements, (3) use of spacecraft data alone (no auxiliary inputs), and (4) radiation transfer models employing inputs such as visual range, temperature, humidity, etc.

C. There are no serious problems inpending the progress of this investigation. An early meeting is needed with the ERTS scientific and technical monitors to resolve details of future field measurement program, including: review of choice of test site, proposed ground truth measurement techniques, aircraft underflight needs (request of 15 June 1972), and ERTS data request (request of 20 June 1972).

D. ACCOMPLISHMENTS

Work (software) has been completed to receive, color code (color slice), and display on computer driven TV display any one band from bulk MSS CCT. Preliminary screening of MSS data gathered over San Francisco demonstrates effectiveness of this mode for locating truth sites.

Major activity since 1 August 1972 has been directed to the design and fabrication of the Radiant Power Measuring Instruments (RPMI). Specific goals achieved during this period include:

- Completed instrument specification (see Attachment 1).
- Developed wood and paper model of RPMI (see Attachment 2).
- Completed RPMI optical and electronic design and 80% of mechanical design.
- RPMI engineering model is 85% assembled and electrical checkout has started.
- Material has been placed on order for four additional RPMIs.

Activities planned for the next reporting period include:

- Complete assembly and calibration of RPMI engineering model by 23 October 1972.
- Assemble, checkout and calibrate four additional RPMIs at a rate of approximately one per week during the month of November 1972.

- Develop descriptive material for ground truth team on how to perform field measurements with RPMI together with forms and logs, etc. needed by the team.

- Start daily (local) field data gathering to determine capability of instruments, and correlation of instrument measurements with meteorological data.

- Meet with ERTS scientific and technical monitors to review RPMI, discuss measurement techniques, atmospheric models, and plans for field test program.

E. Activities to date have been directed towards developing the RPMIs and preparing to receive Bulk MSS CCTs. Therefore, results significant for practical applications and cost-benefit analysis have not been obtained as yet. However, since this experiment is concerned with developing techniques that will permit ERTS data to be transformed into absolute target reflectance signatures, making accurate unambiguous interpretations possible, by all ERTS data users, the cost benefits should be very high.

F. No release of information or requests for permission to release information have been made during the reporting period.

G. Recommendations concerning practical changes will be reviewed with Dr. R. S. Fraser and Mr. E. F. Szjana within the next 30 days.

H. Standing order forms have not been changed, however, Exhibit 2 to this contract does not agree exactly with our product order form submitted 20 June 1972.

I. Attachment of ERTS Image Descriptor Forms is not applicable as yet.

J. Data product form submitted 20 June 1972 to technical monitor.

K. Work to date conforms to schedule, first field measurements will start late October.

RADIANT POWER MEASURING INSTRUMENT FOR ERTS GROUND TRUTH

The Radiant Power Measuring Instrument (RPMI) is a rugged, hand-carried instrument accurately calibrated to measure both downwelling and reflected radiance within each ERTS multispectral scanner (MSS) band. A foldover handle permits a quick change from wide angle global or sky irradiance measurements to narrow angle radiance measurements from sky and ground targets. From these measurements additional parameters such as beam transmittance between spacecraft and ground, path radiance (path reflectance), and reflectance of ground truth site may be determined.

Summary of Characteristics

- Spectral Bands: All measurements made in four bands identical to the ERTS-1 MSS bands (0.5 to 0.6 microns (μ); 0.6 to 0.7μ; 0.7 to 0.8μ; and 0.8 to 1.1μ). Bands formed by bandpass filter in switched turret followed by silicon detector.

- Field of View: Two modes
  1. 2π steradian field of view through removable diffuser.
  2. Handle permits 6° circular field of view for sky and earth measurements.

- Sensitivity (Measurement Ranges):
  12 range scales permit irradiance measurements from 0.001 to 300.0 watts/square meter and radiance measurements from .001 to 300 watts/square meter/steradian.

- Calibration Accuracy:
  1. An absolute accuracy of $\pm$ 5.0% is maintained over the field operating ranges noted below for a period of over 1 year.
  2. Relative (band to band) accuracy is $\pm$ 2.0%.
  3. Repeatability $\pm$ 0.5%.

- Frequency Response:
  1. 0 to 1.0 Hz on meter.
  2. 0 to 1.0 kHz at BNC output.

- Controls: Irradiance/Radiance, Range (12 positions), Band Select (6 positions include the 4 ERTS MSS bands, and a closed and an open position), Meter Zero, Battery Test, and ON/OFF Switch.

- Meter: 3 1/2-inch taut band, 1.0% hand calibrated, mirrored scale, scaled 0 to 1.0 and 0 to 3.0 with 50 and 60 divisions, respectively.

- Power Source: Two replaceable batteries. Options include 9.0-volt batteries typical for transistor radio; or 9.0-volt alkaline batteries for low-temperature operation; battery life nominally 50 to 100 hours.

- Environmental Specifications:
  1. Sealed against dust and humidity to 100%.
  2. Shock and vibration expected in field and aircraft environments.
  3. Storage -55°C to +80°C.
  4. Operational -20°C to +70°C.

- Size: 4 x 7 x 8 in. (10 x 18 x 20 cm).

- Weight: Approximately 5 pounds (2.27 kg) with batteries.

Measurement Modes

1 Global Irradiance (H) - 2π steradian field of view for measuring downwelling (incident) radiation in bands identical to ERTS MSS.

2 Sky Irradiance (H_{SKY}) - Global Irradiance minus direct sun component, in every ERTS MSS band. Angle from zenith to sun is also measured in this mode.

3 Radiance from Narrow Solid Angles of Sky - Handle serving as field stop permits direct measurements through a 6.0° circular field of view. This mode is also used to measure direct beam solar irradiance.

4 Reflected Radiation - Used with small calibration panels, cards, to obtain direct measurement of truth site reflectance. Same field of view as above.

ERTS - Radiant Power Measuring Instrument